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Pham

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(54) **SMART CABINET FOR HOME GARDENING**

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A01G 9/02	(2018.01)
A01G 27/00	(2006.01)
A01G 9/029	(2018.01)

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CPC ***A01G 31/06*** (2013.01); ***A01G 9/023*** (2013.01); ***A01G 9/027*** (2013.01); ***A01G 9/0297*** (2018.02); ***A01G 27/006*** (2013.01); ***A01G 27/008*** (2013.01)

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CPC A01G 31/06; A01G 9/0297; A01G 9/023; A01G 9/027; A01G 27/006; A01G 27/008; A01G 9/022; A01G 9/14; A01G 9/20; A01G 9/24; A01G 9/241; A01G 9/247; A01G 9/26; A01G 9/249; A01G 27/005; A01G 27/001; A01G 27/02; A01G 27/06; A01G 7/045; A01G 9/16; A01G 9/02; A01G 2031/006; A01G 31/02

See application file for complete search history.

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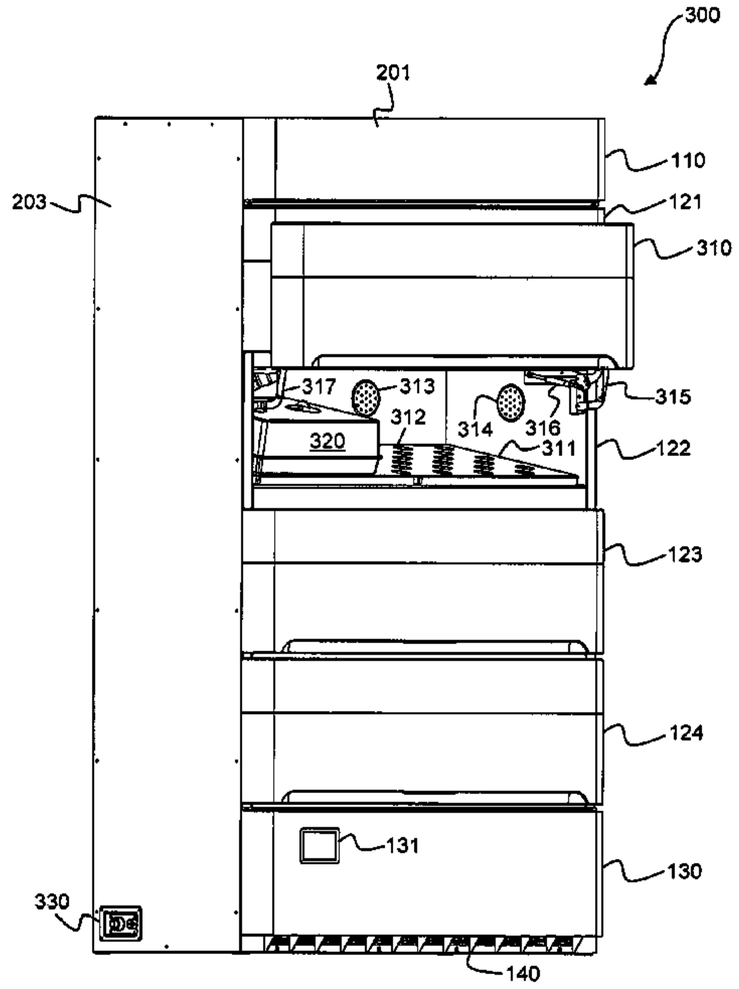
Primary Examiner — Trinh T Nguyen

(57) **ABSTRACT**

A smart home gardening cabinet is disclosed that includes a plurality of plant growing drawers each having a vertical lift door and an automatic precision weather system to grow a specific type of plants, each automatic precision weather system includes an array of lights for photosynthesis, an air circulation system, and a water circulation system that provides nutrient water to the specific plants in each plant growing drawer; each plant growing drawers having a plant growing tray that includes an array of growing holes filled with a sponge materials to absorb and retain nutrients which are misted to the roots of the plants, excess nutrient water being returned to the water circulation system to save water.

20 Claims, 9 Drawing Sheets



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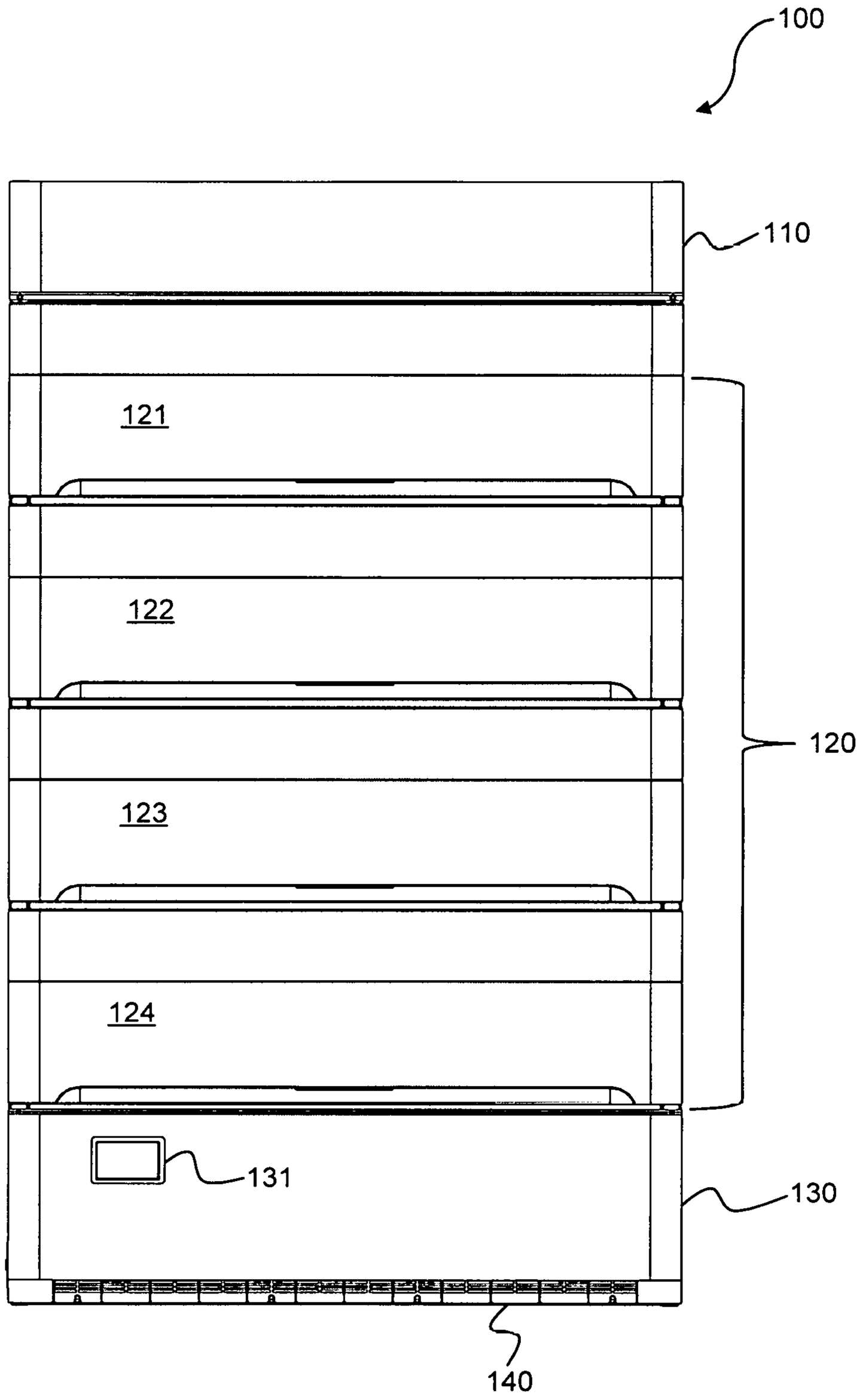


FIG. 1

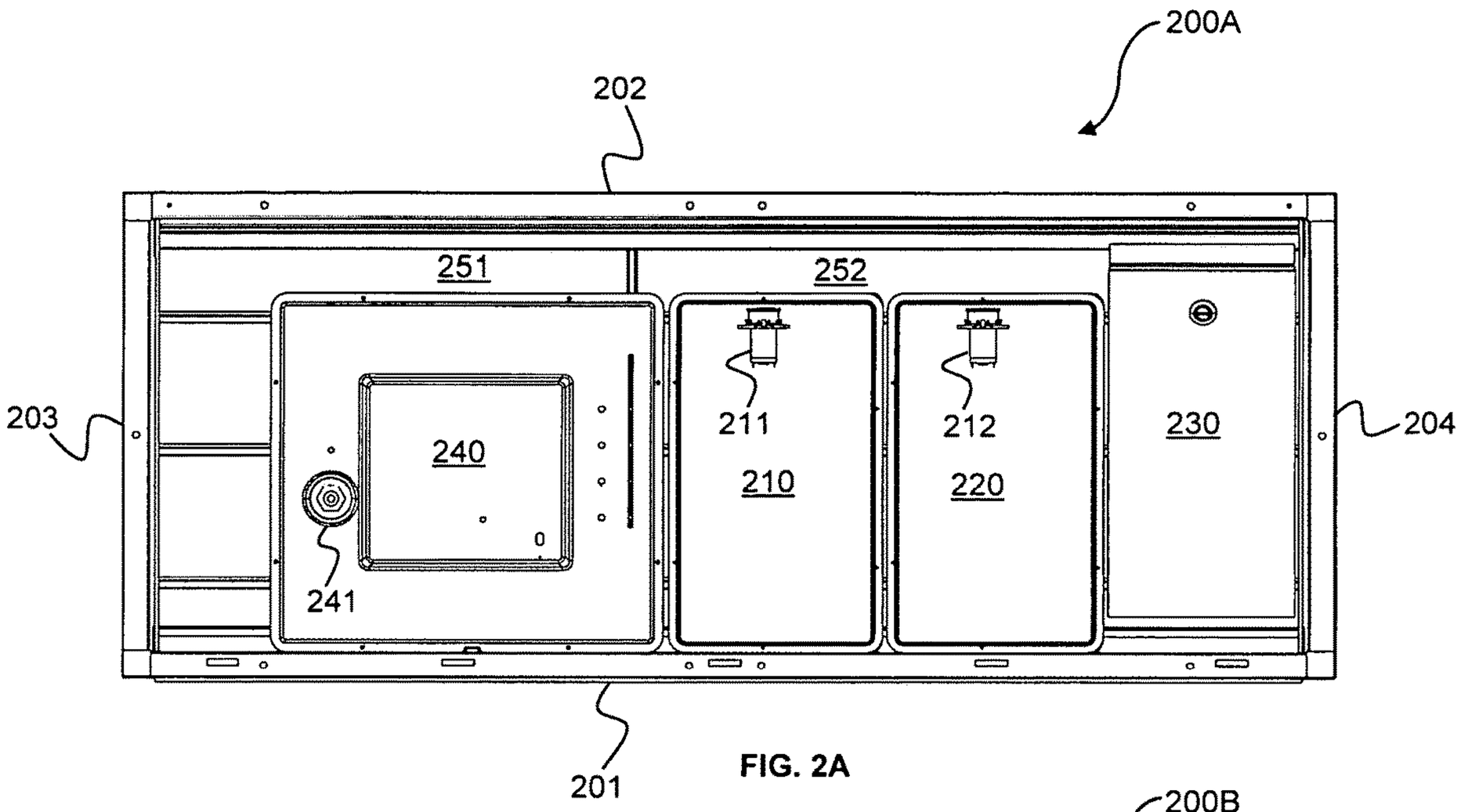

200A
202
251
252
203
240
241
211
210
212
220
230
204
201

FIG. 2A

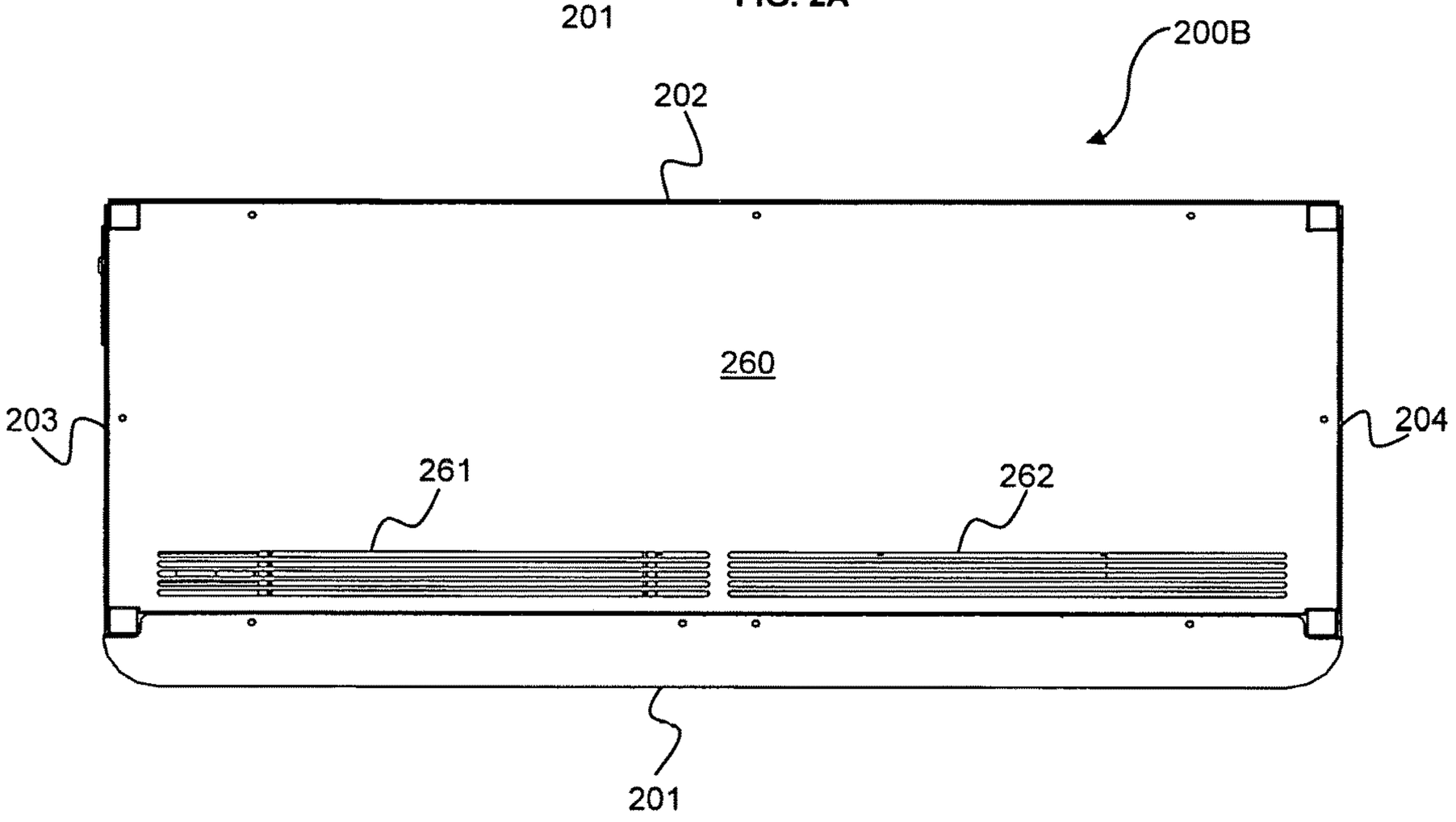

200B
202
260
203
204
261
262
201

FIG. 2B

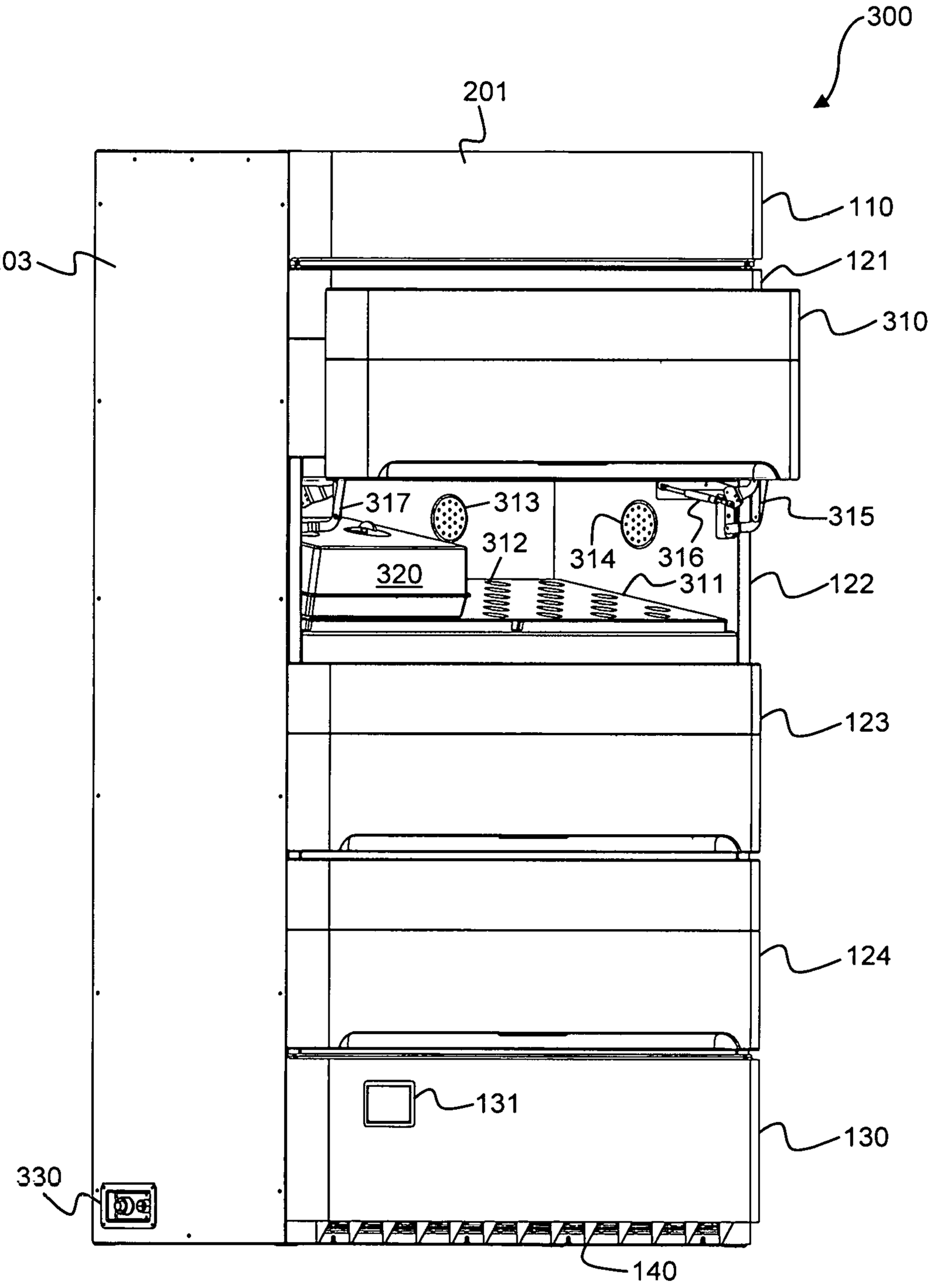

300
201
110
203
121
310
317
313
315
312
314
316
320
311
122
123
124
131
130
330
140

FIG. 3

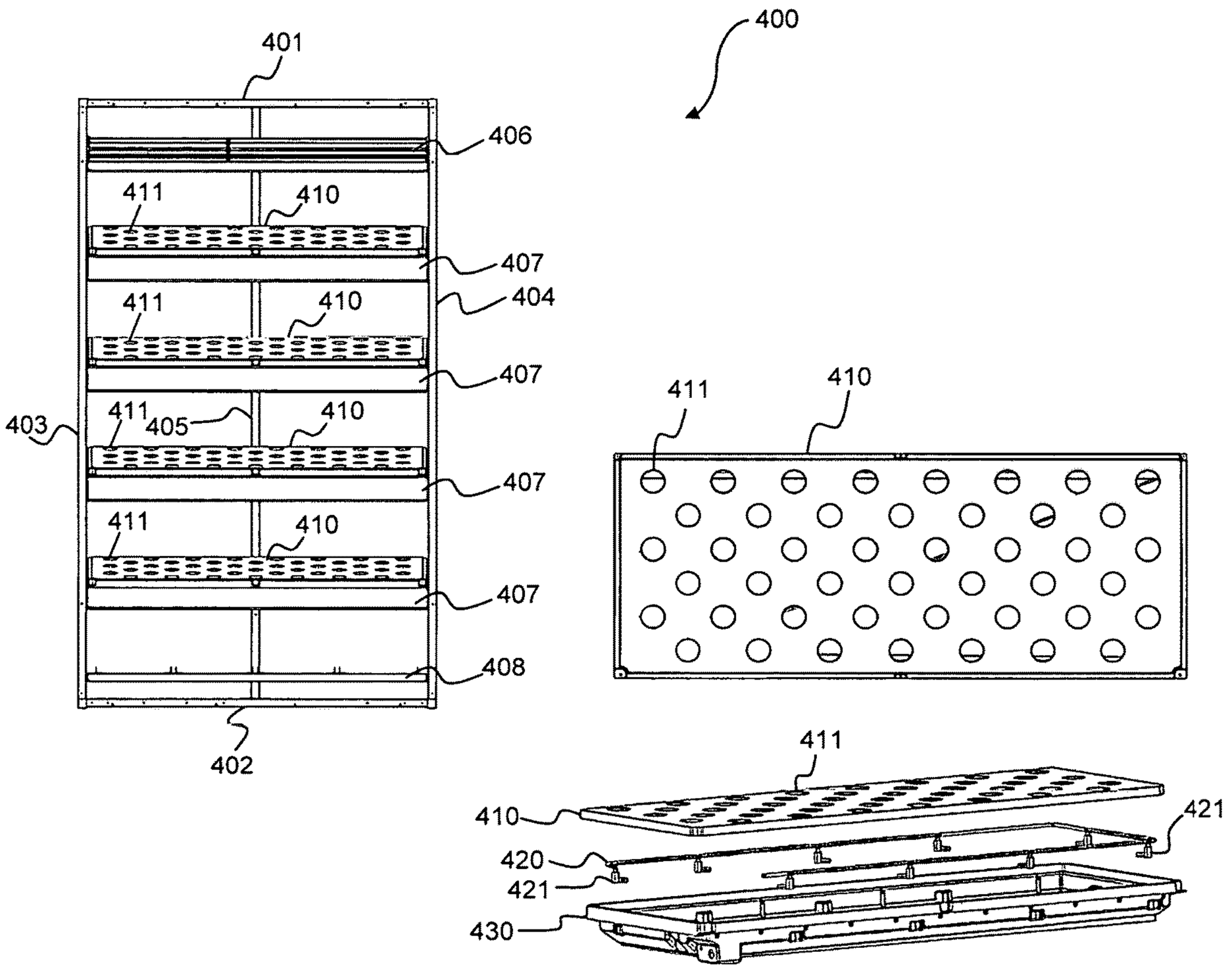

401
400
406
411
410
407
404
411
410
407
403
411
405
410
407
411
410
407
408
402
411
410
411
410
421
420
421
430

FIG. 4

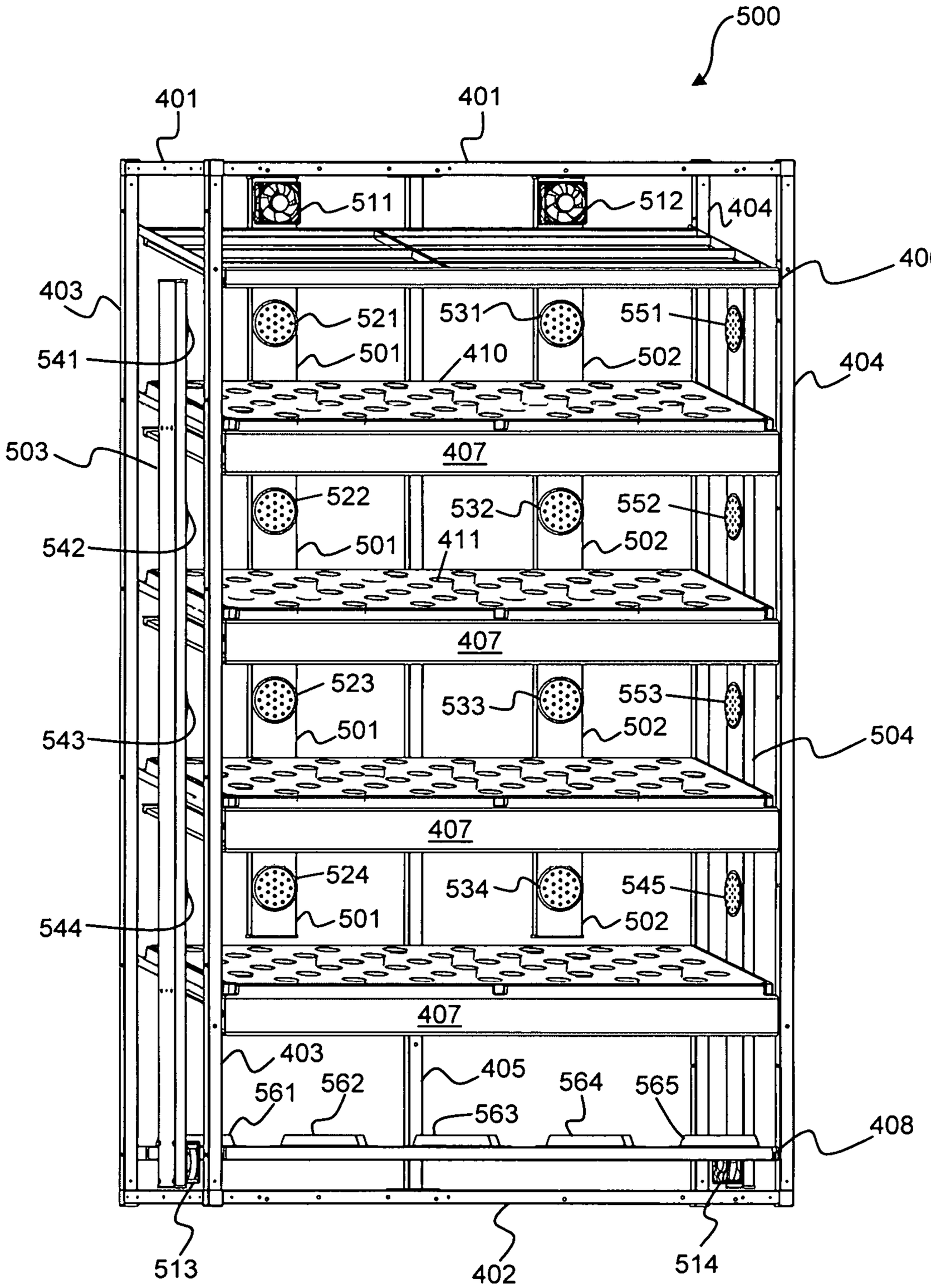
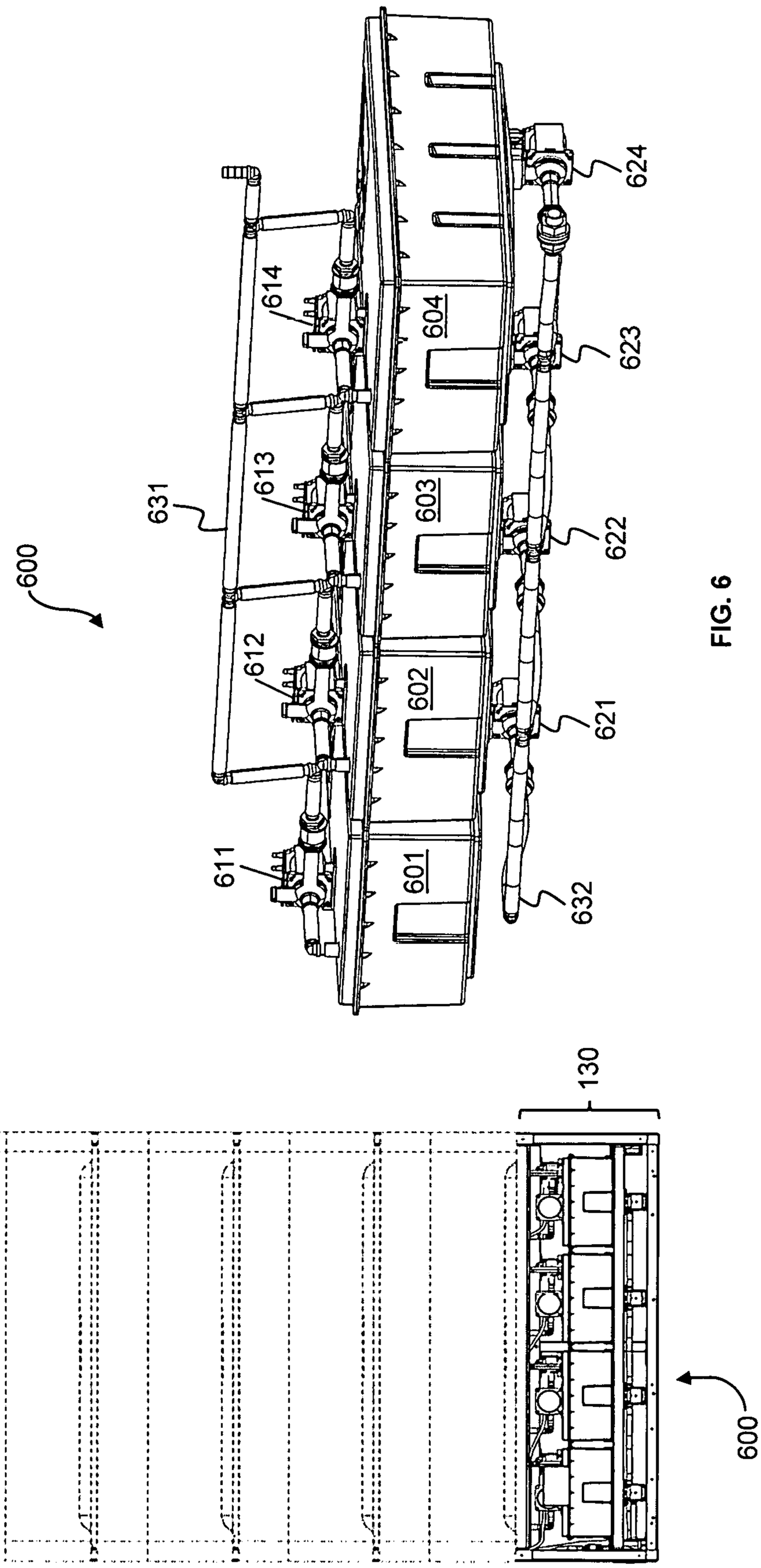

500
401
401
511
512
404
406
403
521
531
551
541
501
410
502
404
407
503
522
532
552
542
501
411
502
407
523
553
543
501
533
502
504
407
524
534
545
544
501
502
407
403
405
564
565
561
562
563
408
513
402
514

FIG. 5


600
611
612
613
614
631
601
602
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604
621
622
623
624
632
130
600

FIG. 6

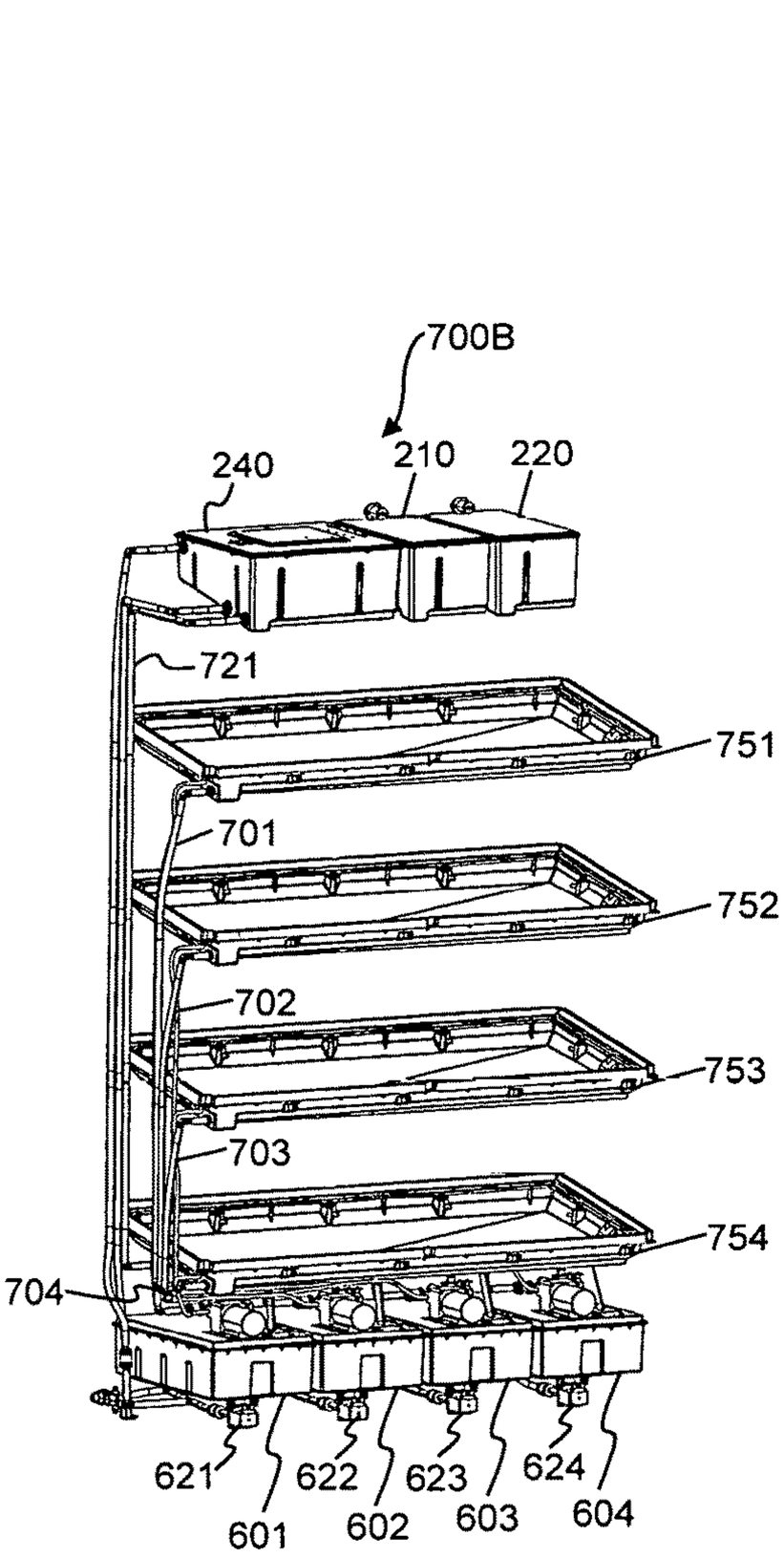
700B
240
210
220
721
751
701
752
702
753
703
754
704
621
622
623
624
601
602
603
604

FIG. 7B

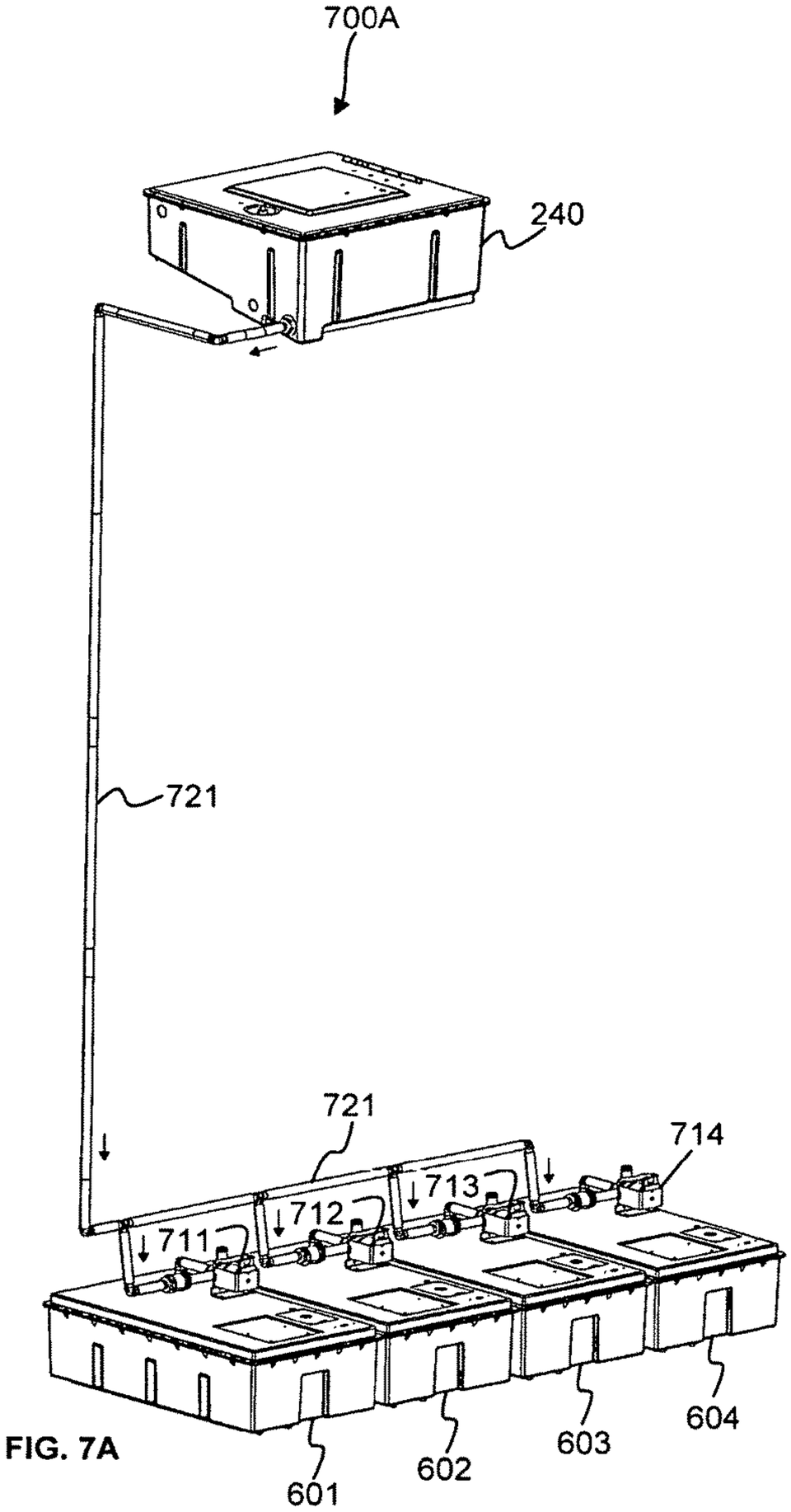
700A
240
721
721
714
713
712
711
601
602
603
604

FIG. 7A

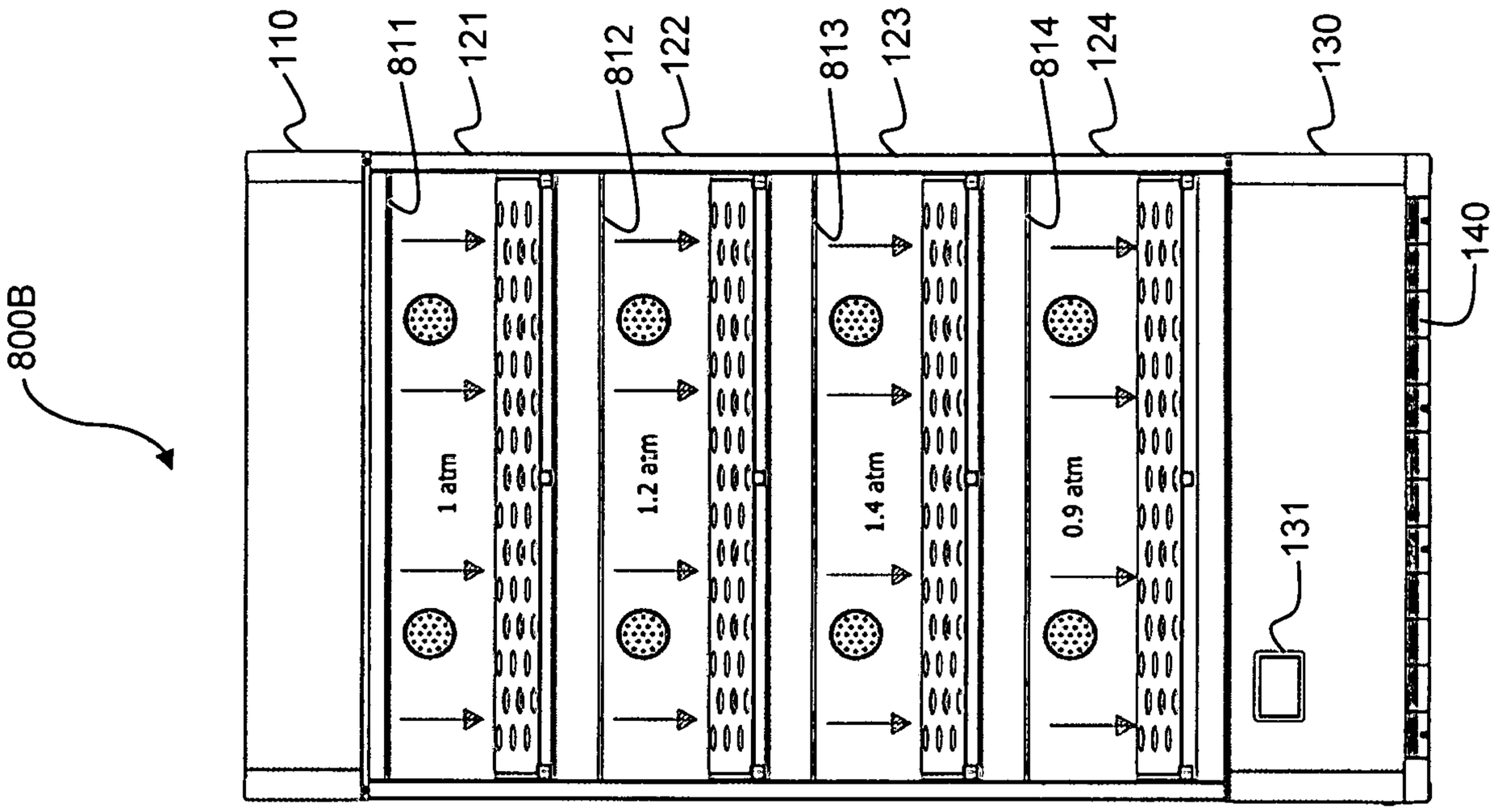
800B
110
811
121
812
122
813
123
814
124
130
140
131
1 atm
1.2 atm
1.4 atm
0.9 atm

FIG. 8B

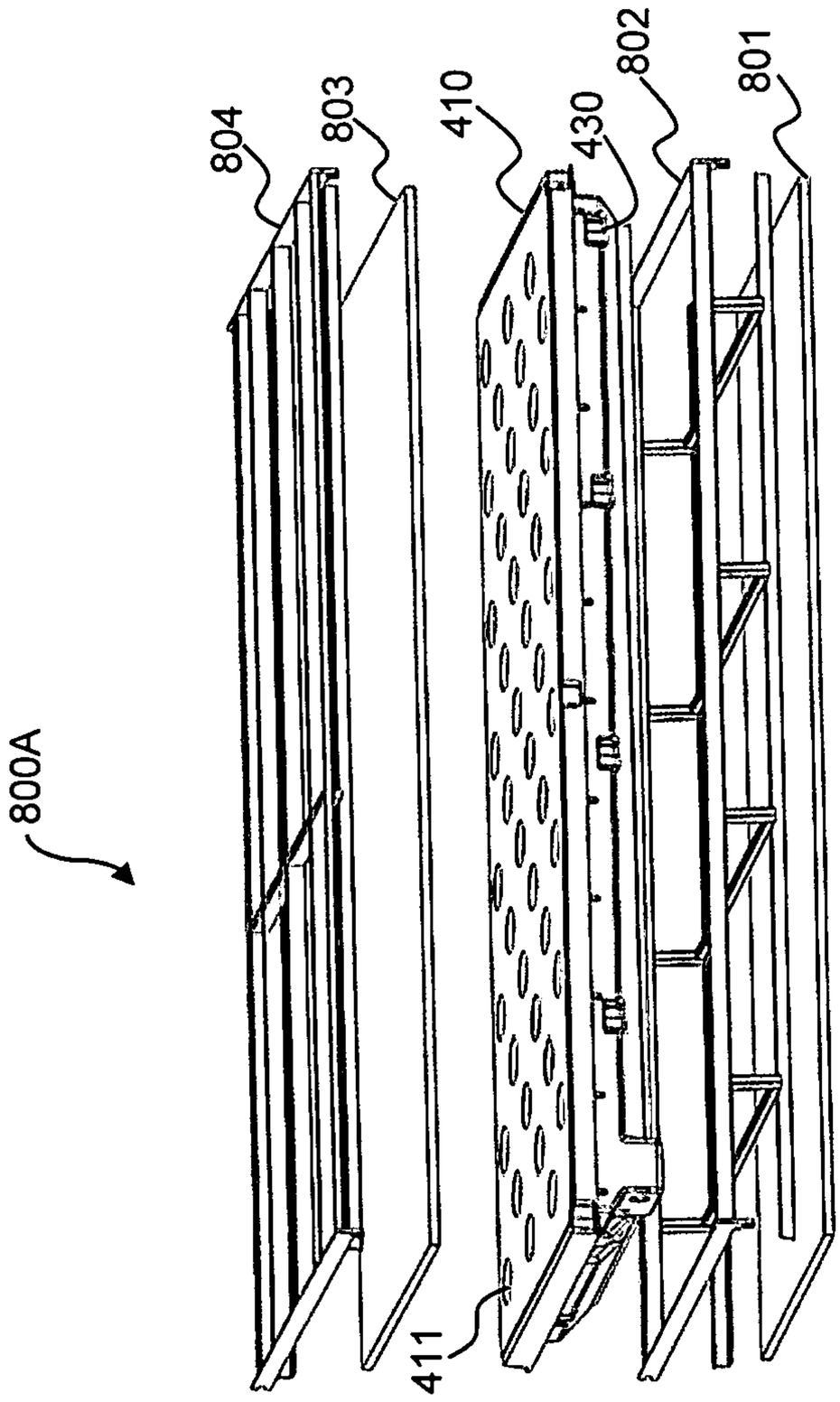
800A
804
803
410
430
802
801
411

FIG. 8A

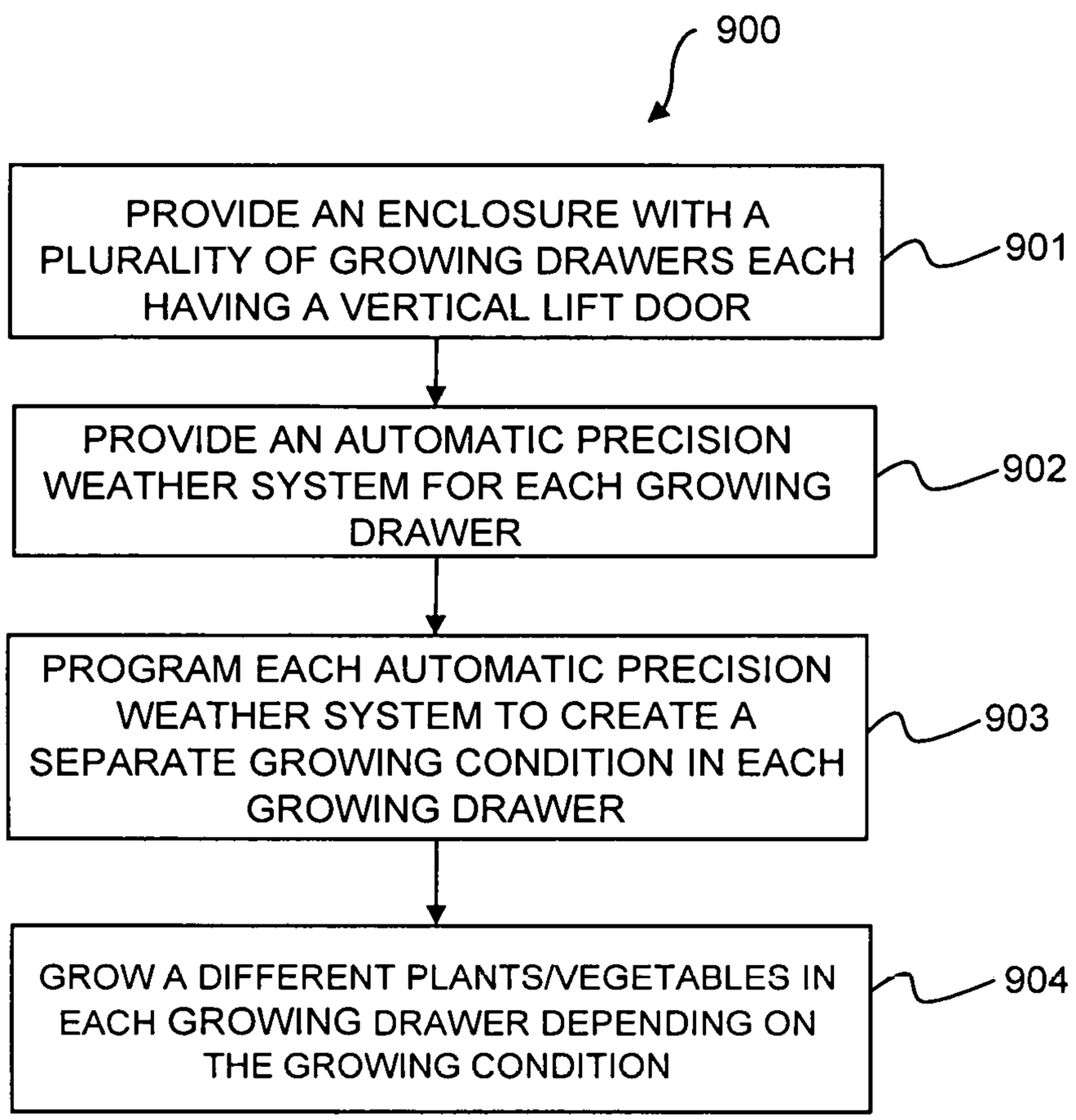
900
PROVIDE AN ENCLOSURE WITH A PLURALITY OF GROWING DRAWERS EACH HAVING A VERTICAL LIFT DOOR
901
PROVIDE AN AUTOMATIC PRECISION WEATHER SYSTEM FOR EACH GROWING DRAWER
902
PROGRAM EACH AUTOMATIC PRECISION WEATHER SYSTEM TO CREATE A SEPARATE GROWING CONDITION IN EACH GROWING DRAWER
903
GROW A DIFFERENT PLANTS/VEGETABLES IN EACH GROWING DRAWER DEPENDING ON THE GROWING CONDITION
904

FIG. 9

SMART CABINET FOR HOME GARDENING

CROSS REFERENCE TO RELATED APPLICATION

This non-provisional utility patent application claims priority filing benefit of U.S. Provisional Patent No. 62/608,358 filed Dec. 20, 2017, which is hereby incorporated by reference in its entirety.

FIELD OF THE INVENTION

The present invention relates generally to the field of plant agriculture. More specifically, the present invention relates to devices for home gardening.

BACKGROUND ART

The trend for organic gardening at home and in restaurants keeps increasing. Homeowners and restaurenteurs in cities want to consume healthier organic plants and vegetables that they either (1) know the growing conditions, and (2) control or grow themselves. Nutrient-rich and healthy organic plants and vegetables free of disease, pest resistance, and without the use of chemicals are in high demand. For the healthiest plants and vegetables, the optimal growing conditions are required.

Since soils deteriorate with time. Menure and compost are used to enrich the soils. However, the traditional growing method using soils require a large land area and soils are difficult to maintain. Different methods of healthy plant/vegetables growing in urban settings include areoponics and hydroponics. Hydroponics is noticeably better than conventional farming methods since the basic requirements of a plant are few-water, sunshine, and nutrients. In a hydroponic system, a plant does not need an extensive root system because it does not have to expend energy seeking nutrients as it does when grown in the ground. Aeroponics is a method of growing plants in a moist environment. The plants are suspended in an enclosed setting and water, mixed with plant food, is sprayed onto the roots. Aeroponics systems are frequently employed in an enclosed environment like a greenhouse so that the temperature and humidity can be accurately regulated. Although sunlight is the principal light source, some additional lighting may also be added.

In an aeroponics system, the roots of the plants are misted with nutrients, water, and oxygen. Using a closed loop system, 95% less water than field farming is used and 40% less than hydroponics. LED lights are used to create a precise light formula for each plant, giving the plants the exact range, intensity, and frequency that the plants require for photosynthesis in the most energy-efficient way. With aeroponics, a grower can take the exact same seed from the field and grow it in half the time as a traditional field farmer, leading to 390 times more productivity per square foot than a commercial field farm. Using aeroponic technology, researchers discovered the yields of plants grown were more than 30% larger on average. For example, red kale had a 65% increase, bell peppers had a 53% increase, cucumbers were 7% larger, and squash 50%. Both aeroponic and soil growing methods produced comparable nutritional value. With traditional growing methods in soil, a lot of space is required. The problem is that we have less and less of it, and we are losing about 3,000 acres of farmland to development every day. But growing aeroponics vertically requires only 10% of the room traditional farming needs.

In a U.S. Patent Publication Application No. US-2017/0347547 by Lu et al. (hereinafter referred to as the "'547 application"), Lu et al. disclose a cabinet for growing plants hydrophonically. The '547 application discloses a housing including different modules for automatic refilling of nutrient and disposing of sewage water. However, the growing area includes pods that can grow only one type of plant/vegetable at a time. Furthermore, the manner the pods are arranged, the '547 application cannot grow a sufficient amount of plants and can grow one type of plant at a time. That means, the user has to wait until one type of plant is harvested to grow another type of plant. Consequently, he/she has to reset the growing condition of the cabinet. Healthy consumption requires a variety of vegetables such as salads, tomatoes, onions, etc.

In addition, the door of the cabinet of the '547 application is designed to open outward, taking about three times more of spaces for the prior-art cabinet to fully operate. Thus, the operational space for the '547 application cabinet is the total of the thickness of the cabinet, the width of the door, and the space for the free movement of the user.

The air circulation system including fans of the '547 application cabinet is designed to blow directly into the plants as shown in FIG. **2**. This arrangement increases the risk of damaging the plants/vegetables in the pod.

Continuing with the discussion of the prior-art cabinet of the '547 application, the water system and the arrangement of vertical growing pods are designed to save water. However, this arrangement increases the risk of creating uneven growing conditions. Those plants on top near the water source will have more nutrient than those in the bottom. Plants/vegetables on different levels will receive different amount of nutrients. Similarly, the lateral lighting device would adversely affect plants/vegetables qualities because those pods are far away from the lateral lighting will get lower lighting condition and photosynthesis.

Therefore what is needed is a smart growing cabinet that can grow different types of plants at the same time.

This means that, what is needed is smart growing cabinet that can simultaneously create different and precise growing conditions for different types of plants/vegetables at the same time.

Yet, what is needed is a smart growing cabinet that is mechanically designed so that it takes less rooms to operate, i.e., for users to go in and out to harvest or to control the conditions of the cabinet, facilitating healthy gardening in narrow home spaces.

Yet, what is needed is a smart growing cabinet that can create a balanced and even ventilation, lighting conditions, and nutrient level for all sorts of plants/vegetables.

The present invention provides solutions to the abobe needs.

SUMMARY OF THE INVENTION

Accordingly, an objective of the present invention is to provide a smart home gardening cabinet that includes a plurality of plant growing drawers each having a vertical lift door and an automatic precision weather system to grow a specific type of plants, each automatic precision weather system includes an array of lights for photosynthesis, an air circulation system, and a water circulation system that provides nutrient water to the specific type of plants in each plant growing drawer; each plant growing drawer having a planting tray that includes an array of planting holes filled with a sponge materials to absorb and retain nutrients which

are misted to the roots of the plants, excess nutrient water being returned to the water circulation system to save water.

Another objective of the present invention is to provide a method for home gardening that includes providing a closed enclosure having a plurality of plant growing drawers, each having a vertical lift door; providing an automatic precision weather system (APWS) configured to set specific growing condition for each of plurality of plant growing drawers, setting a specific growing condition for each plant growing drawer based on the set growing conditions; and growing and cultivating specific plants/vegetables in each plant growing drawer.

Another objective of the present invention is to provide a computer-implemented software program for controlling an automatic precision weather system (APWS) for a smart cabinet that includes selecting a specific plant to grow in each of a plurality of plant growing drawers; filling water to a proper level in a mixing chamber; pouring a nutrient solution into the mixing water tank until the specific water nutrient water is reached; moving the specific water-nutrient solution mixture to one of the plurality of water-nutrient solution mixture containers; repeating the above steps until all containers of the plurality of water-nutrient solution mixture containers are filled with different specific water-nutrient solution mixtures for different specific plants; and controlling the automatic precision weather system (APWS) to provide the specific growing condition to specific plant in each of the plurality of plant growing drawers.

Another objective of the present invention is to provide a smart plant growing cabinet configured to grow different types of plants at the same time. This means that, what is needed is smart plant growing cabinet that can create different precise growing conditions for different types of plants/vegetables.

Another objective of the present invention is to provide a smart plant growing cabinet that is mechanically designed so that it takes less rooms to operate, i.e., for users to go in and out to harvest or to control the conditions of the cabinet.

Another objective of the present invention is to provide a smart plant growing cabinet that can create a balanced and even ventilation, lighting conditions, and nutrient level for all plants/vegetables.

These and other advantages of the present invention will no doubt become obvious to those of ordinary skill in the art after having read the following detailed description of the preferred embodiments, which are illustrated in the various drawing Figures.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are incorporated in and form a part of this specification, illustrate embodiments of the invention and, together with the description, serve to explain the principles of the invention.

FIG. **1** is a schematic diagram of a smart cabinet for home gardening in accordance with an embodiment of the present invention;

FIG. **2**A is a top view of the top section of the smart cabinet for home gardening in accordance with an embodiment of the present invention;

FIG. **2**B is is a top view of the top section of the smart cabinet with a lid fastened on to show the array of air input slits in accordance with an embodiment of the present invention;

FIG. **3** is a perspective diagram showing the open position of a vertical lift door exposing the inner structure of a plant growing drawer of the smart cabinet for home gardening in accordance with an embodiment of the present invention;

FIG. **4** is a schematic diagram illustrating the frame structure of the smart cabinet and the components of the plant growing tray in accordance with an exemplary embodiment of the present invention;

FIG. **5** is a schematic diagram illustrating the frame and the air circulation system of the smart cabinet for home gardening in accordance with an exemplary embodiment of the present invention;

FIG. **6** is a schematic diagram illustrating the water-nutrient solution mixture containers—one for each plant growing drawer—in the bottom section of the smart cabinet for home gardening in accordance with an exemplary embodiment of the present invention;

FIG. **7**A is a schematic diagram of the water return system—a part of the water circulation system—in accordance with an embodiment of the present invention;

FIG. **7**B is a schematic diagram of the complete water circulation system that provides water nutrient solution mixture to and receives excess water from each plant growing drawer in accordance with an embodiment of the present invention;

FIG. **8**A is a schematic diagram of a lighting system integrated into a plant growing tray in accordance with an embodiment of the present invention;

FIG. **8**B is a schematic diagram of the smart cabinet with the lighting system in each of the plant growing cabinet in accordance with an embodiment of the present invention; and

FIG. **9** is a flow chart of a method for home gardening of different types of plants simultaneously in a cabinet in accordance with an embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

Reference will now be made in detail to the preferred embodiments of the invention, examples of which are illustrated in the accompanying drawings. While the invention will be described in conjunction with the preferred embodiments, it will be understood that they are not intended to limit the invention to these embodiments. On the contrary, the invention is intended to cover alternatives, modifications and equivalents, which may be included within the spirit and scope of the invention as defined by the appended claims. Furthermore, in the following detailed description of the present invention, numerous specific details are set forth in order to provide a thorough understanding of the present invention. However, it will be obvious to one of ordinary skill in the art that the present invention may be practiced without these specific details. In other instances, well-known methods, procedures, components, and circuits have not been described in detail so as not to unnecessarily obscure aspects of the present invention.

Many aspects of the present invention are now described with reference to FIG. **1**-FIG. **8**. FIG. **1** illustrates a schematic diagram of a smart cabinet **100** for home gardening in accordance with an exemplary embodiment of the present invention.

In a general implementation of the present invention, smart cabinet **100** is a closed enclosure that includes a top section **110**, a middle section **120**, and a bottom section **130**, each having a different function. Top section **110** is dedicated for pre-gardening and controlling functions. Middle section has a plurality of plant growing drawers **121**-**124** for growing different plants, depending on their specific grow-

ing conditions. Examples of specific growing conditions include but not limited to pH level, nutrient ratio, and ambient weather. Bottom section **130** is dedicated to contain specific water-nutrient mixture containers for each specific plant in each specific plant growing drawers **121-124**. In one exemplary embodiment of the present invention, bottom section **130** also includes a touch screen display **131** for displaying and controlling the growing conditions for each plant growing drawer **121-124**. Finally, an air outlet openings **140** are formed at the bottom of bottom section **130**. Now referring next to FIG. **2**A, a top view diagram of smart cabinet for home gardening **100** showing the components of a top section **200**A is illustrated. As seen, top section **200** as well as smart cabinet **100** has a front side **201**, a back side **202**, a left side **203**, and a right side **204**. Top section **200** includes a pair of containers **210-220** that are used to contain organic solutions, a controller circuit **230** contained inside a box, a mixing tank **240** where the mixing between water and organic solution occur to produce a specific water-nutrient solution mixture for a specific plant. Mixing tank **240** has a nutrient sensor **241** that measures the water-nutrient ratio of a specific water-nutrient solution mixture in term of total dissolved solution (TDS) or par per million (PPM). Similarly, containers **210-220** has a nutrient sensors **211** and **221** respectively. Top section **200**A also contains a pair of suction fans and air filters **251-252** designed to create a clean air flow within smart cabinet **100**. In one exemplary embodiment of the present invention, the speed of suction fans and air filters **251-252** are controlled by controller circuit **230**.

Continuing with FIG. **2**B, a schematic diagram of top section **110** with the lid fastened thereon so that air input slits are shown. A top lid **260** with arrays of air input slits **261-262** is fastened on top of top section **110**. In many aspects of the present invention, an air circulation whose velocity can be controlled by controller circuit **230** is formed inside smart cabinet **100**. Air is entered at arrays of input slits **261-262**, filtered to remove impurities, circulated inside each drawers **121-124**, and exited at air outlet openings **140**. The detailed air circulation system of the present invention is described later.

Next referring to FIG. **3**, a perspective diagram showing the open position of a vertical lift door **310** exposing the inner structure **300** of a drawer of the smart cabinet for home gardening in accordance with an embodiment of the present invention is illustrated. Vertical lift door **310** is attached to the right inner wall of plant growing drawer **122** by an upward curved hinge **315**. A second curved hinge **316** attaches vertical lift door **310** to the left inner wall of drawer **122**. A right pneumatic arm **316** and a left pneumatic arm **318** (not shown) is mechanically fastened so that vertical lift door **310** can open or close in a fashion that is almost parallel to the front surface of smart cabinet **100**. Inside plant growing drawer **122**, a plant growing tray **311** with an array of circular openings are formed on the top surface of plant growing tray **311**. In one exemplary embodiment of the present invention, seedling box **320** is placed inside plant growing drawers **121-124** to grow seedlings for a specific plant. On the back wall **202**, a pair of air inlet openings **313** are placed on the back wall of plant growing drawer **122**. On the right side wall, an air outlet opening **314** is positioned. Near the bottom of right side **202**, a water input/output faucet **330** that receives water from an external source is located.

FIG. **4** is a schematic diagram illustrating a frame structure **400** of the smart cabinet and the components of the plant growing tray in accordance with an exemplary embodiment of the present invention. Frame structure **400** is made of metal frames including top frame bars **401**, bottom frame bars **402**, left frame bars **403**, and right frame bars **404** mechanically connected together. A top section base **406**, middle section bases **407**, and a bottom base **408** are mechanically connected to frame structure **400** to form top section **110**, middle section **120**, and bottom section **130** respectively as described in FIG. **1** above. A vertical bar **405** mechanically connects top bars **401**, bases **406-408**, and bottom base **408** together to strengthen frame structure **400**. A plurality of plant growing trays **410** is fastened to each middle section bases **407**. As alluded above, plant growing tray **410** has an array of circular openings **411** for growing a specific plant. Right underneath plant growing tray **410** is a spraying tube **420** and sprinkler heads **421** that directly spray water-nutrient solution mixture directly to roots of the specific plant grown on each circular opening **411**. In one exemplary embodiment, spraying tube **420** is formed around the perimeter to plant growing tray **410** and a water container **430**. Water container **430** is laid underneath plant growing tray **410** to collect excess water.

Referring next to FIG. **5**, a schematic diagram illustrating the frame and the air circulation system **500** of smart cabinet for home gardening **100** in accordance with an exemplary embodiment of the present invention is illustrated. As described in FIG. **4** above, smart cabinet **100** is built from frame structure **400** made of top frame bars **401**, bottom frame bars **402**, left frame bars **403**, and right frame bars **404** mechanically connected together. A first hollow rectangular tube **501** and a second hollow rectangular tube **502** are connected to frame **400**, top section bases **406**, middle section bases **407**, and bottom section **408**, which is parallel to vertical ba **405**. In the space of top section **110**, first air suction fan **511** and a second air suction fan **512** are connected face first to first hollow rectangular tube **501** and second hollow rectangular tube **502** respectively. A third hollow rectangular tube **503** is connected to left frame bars **403** and a fourth hollow rectangular tube **504** is connected to right frame bars **404**. In the space of bottom section **130**, a third air suction fan **513** is connected to third hollow rectangular tube **503**, and a fourth air suction fan **514** is connected to fourth hollow rectangular tube **504**. Controller circuit provides power supplies and control the speed of all four suction fans **511-514**. In one exemplary embodiment of the present invention, first air suction fan **511** and second air suction fan **512** are includes air filters (not shown) to filter out impurities from the ambient environment outside of smart cabinet **100**. It is noted that first air suction fan **511** is the same as first suction fan and air filter **251** and second air suction fan **512** is the same as second suction fan and air filter **252**. Referring again to FIG. **1**, in the space of first plant growing drawer **121**, four circular air openings **521**, **531**, **541**, and **551** are connected to first hollow rectangular tube **501**, second hollow rectangular tube **502**, third hollow rectangular tube **503**, and fourth hollow rectangular tube **504** respectively. Similarly, in the space of second plant growing drawer **122**, four circular air openings **522**, **532**, **542**, and **552** are connected to the same first hollow rectangular tube **501**, second hollow rectangular tube **502**, third hollow rectangular tube **503**, and fourth hollow rectangular tube **504** respectively. In the space of third plant growing drawer **123**, four circular air openings **523**, **533**, **543**, and **553** are connected to first hollow rectangular tube **501**, second hollow rectangular tube **502**, third hollow rectangular tube **503**, and fourth hollow rectangular tube **504** respectively. Finally, in the space of fourth plant growing drawer **124**, four circular air openings **524**, **534**, **544**, and **554** are connected to first hollow rectangular tube **501**, second

hollow rectangular tube **502**, third hollow rectangular tube **503**, and fourth hollow rectangular tube **504** respectively. In the space of bottom section **124**, four base areas **562-565** are decicated to four water-nutrient solution mixture chambers (will be shown in FIG. **6**). An area **561** is dedicated to touchscreen display and **131** circuitry is shown.

Referring again to FIG. **5**, in operation, first air suction fan **511** and second air suction fan are located in top section **110** close to first array of air input slits **261** and second array of air input slits **262**. Third air suction fan **513** and fourth air suction fan **514** are located in bottom section **130** close to air outlet openings **140**. When turned on, first air suction fan **511** and second air suction fan **512** draw and filter air from outside into top section **110**. This filtered air is drawn vertically downward because of gravity. In first plant growing drawer **121**, air is pushed down via first hollow rectangular tube **521** and second hollow rectangular tube **531**. This air is entered and filled first plant growing drawer **121** via first circular opening **521** and second circular opening **531**. Then, air is pushed out of first plant growing drawer **121** via third circular opening **541** and fourth circular opening **551**. The same air circulation event happens in second plant growing drawer **122** via first, second, third, fourth hollow rectangular tubes **501-504**, air circular openings **522**, **532**, **542**, and **552**. Then, air is circulated in third plant growing drawer **123** via first, second, third, fourth hollow rectangular tubes **501-504**, air circular openings **523**, **533**, **543**, and **553**. Finally, air is pushed down to fourth plant growing drawer **124** via first, second, third, fourth hollow rectangular tubes **501-504**, air circular openings **524**, **534**, **544**, and **554**. After providing air, and other gases such as carbon dioxide (CO_2) for photosynthesis, air is exited smart cabinet **100** via air outlet openings **140**.

FIG. **5** above discloses the air ventilation system built-in into the frame of smart cabinet **100**, now FIG. **6** and FIG. **7** disclose the water-nutrient solution distribution system in accordance with various embodiments of the present invention.

Referring now to FIG. **6**, a schematic diagram illustrating the water-nutrient solution mixture containers **600**—one for each plant growing drawer—in the bottom section **130** of smart cabinet for home gardening **100** in accordance with an exemplary embodiment of the present invention. As shown, water-nutrient solution mixture containers **600** includes a first water-nutrient solution mixture container **601** for first plant growing drawer **121**, a second water-nutrient solution mixture container **602** for second plant growing drawer **122**, a third a first water-nutrient solution mixture container **603** for first plant growing drawer **123**, and a fourth water-nutrient solution mixture container **604** for first plant growing drawer **124**. Next, a first distribution pump/valve device **611** is connected to first water-nutrient solution mixture container **601**, a second distribution pump/valve device **612** is connected to first water-nutrient solution mixture container **602**, a third distribution pump/valve device **613** is connected to third water-nutrient solution mixture container **603**, and a fourth distribution pump/valve device **614** is connected to fourth water-nutrient solution mixture container **604**. A distribution conduit **631** connects all distribution pump/valve devices **611-614** to containers **601-604** together. To control the temperature of each water-nutrient solution mixture device **601-604**, a first cooling valve **621** is connected to control the temperature of first water-nutrient solution mixture container **601**, a first cooling valve **622** is connected to control the temperature of second water-nutrient solution mixture container **602**, a third cooling valve **623** is connected to control the temperature of third water-nutrient solution mixture container **603**, and a fourth cooling valve **624** is connected to control the temperature of fourth water-nutrient solution mixture container **604**. A cooling conduit **632** connects all cooling valves **621-624** and containers **601-604** to a cooling system (not shown).

Now FIG. **7**A-FIG. **7**B describes the water circulation system of the present invention. FIG. **7**A shows a schematic diagram of the water circulation system **700**A from mixing tank **240** to water-nutrient solution mixture containers **601-604**. Connection pipe **721** connects mixing tank **240** to a first receiving pump/valve **711**, a second receiving pump/valve **712**, a third receiving pump/valve **713**, and a fourth receiving pump/valve **714**. First receiving pump/valve **711** is, in turn, connected to first water-nutrient solution container **601** to provide water nutrient to first plant growing drawer **121**. Second receiving pump/valve **712** is connected to second water-nutrient solution container **602** to provide nutrient to second plant growing drawer **122**. Third receiving pump/valve **713** is connected to third water-nutrient solution container **603** to provide nutrient to third plant growing drawer **123**. Fourth receiving pump/valve **714** is connected to fourth water-nutrient solution container **604** to provide nutrient to fourth plant growing drawer **122**. First to fourth distribution pump/valve devices **611-614** and first to fourth receiving pump/valve **711-714** form a complete water circulation system as described in FIG. **7**B as followed.

Referring now to FIG. **7**B, a schematic diagram of a complete water circulation system **700**B in accordance with an exemplary embodiment of the present invention is shown. From top section **110**, mixing tank **240**, after received the correct water-nutrient solution mixture from first and second organic containers **210** and **220**, shall fill up either first to fourth water-nutrient solution mixture containers **601-604** by distribution pipes **731**. First to fourth receiving pump/valve devices **711-714** under the control of controller circuit **230** decides which water-nutrient solution mixture containers **601-604** be filled. Similarly, this filling-in sequence of the proper water-nutrient solution mixtures for all water-nutrient solution mixture containers **601-604** is completed. Then, controller circuit **230** decides which first to fourth water-nutrient solution mixture containers **601-604** to supply water-nutrient mixtures to which water tray **751-754**. In one exemplary embodiment of the present invention, first water-nutrient solution mixture container **601** supplies water nutrient solution mixture for first water tray **751** in first plant growing drawer **121** via first water pipe **701** where group I type of plants such as cress adapted to grow in a water-nutrient ratio of approximate 40 part per million (ppm) and pH level between 6.0 to 7.0. Second water-nutrient solution mixture container **602** supplies water nutrient solution mixture for second water tray **752** in second plant growing drawer **122** via second water pipe **702** where group II type of plants such as artichokes, corrianders, asparagus, lettuce, cinnamon adapted to grow in a water-nutrient ratio of approximate 540-1,000 part per million (ppm) and pH level between 6.0 to 7.0. Third water-nutrient solution mixture container **603** supplies water nutrient solution mixture for third water tray **753** in third plant growing drawer **123** via third water pipe **703** where group III type of plants such as beans, bell peppers, carrots, cauliflowers, radishes, mints, and basils adapted to grow in a water-nutrient ratio of approximate 1,200-1,600 part per million (ppm) and pH level between 6.0 to 6.5. Fourth water-nutrient solution mixture container **604** supplies water nutrient solution mixture for fourth water tray **754** in fourth plant growing drawer **124** via fourth water pipe **704** where group 4 type of plants such as tomatoes, cabbage, and beans

adapted to grow in a water-nutrient ratio of approximate 1,700-2,100 part per million (ppm) and pH level between 5.5 to 6.5. It is noted that any groups of plants and vegetables with suitable water-nutrient ratio in ppm or in TDS and pH level range can be grown using smart cabinet **100** of the present invention and that the present invention is not limited to the groups of plants cited above. Any excess water in first to fourth water trays **751-754** is returned to appropriate water-nutrient solution mixture containers **701-704** via receiving pump/valve devices **711-714**.

Next, referring to FIG. **8**A, a schematic diagram of a lighting system **800**A integrated into a plant growing tray in accordance with an embodiment of the present invention is shown. From the bottom, a base **801** is laid on middle section base **407**, a base frame **802** contains water container **430** and sprinkler heads **421**. Next, lighting system **800**A includes a glass cover **803** is connected to an array of lights **804**. In one exemplary embodiment of the present invention, array of lights **804** is made of an array of light emitting diodes (LEDs) configured to operate in the visual spectrum of wavelengths ranging from 380 nm to 880 nm. However, it is noted that any wavelengths suitable to cultivate any plants/vegetables are within the scope of the present invention.

Now, FIG. **8**B shows a schematic diagram of smart cabinet **100** having lighting system **800**B in each of plurality of plant growing drawers in accordance with an exemplary embodiment of the present invention. A first LED lighting system **811** is connected to the roof of first plant growing drawer **121**, a second LED lighting system **812** is connected to the roof of second plant growing drawer **122**, a third LED lighting system **813** is connected to the roof of third plant growing drawer **123**, and a fourth LED lighting system **814** is connected to the roof of fourth plant growing drawer **124**. As such the lighting systems **811-814**, air circulation systems **521-551**, **522-552**, **523-553**, **524-554**, array of air input slits **260-261**, air output slits **140**, water circulation systems **600-700** as described in FIG. **6**, FIG. **7**(A), and FIG. **7**(B) form an automatic precision weather system (APWS) for each plant growing drawer **121-124**. As alluded above, the automatic precision weather system is controlled by controller circuit **230** to create a specific favorable plant growing condition in each plant growing drawer **121-124**. In one exemplary embodiment of the present invention, the automatic precision weather system (APWS) is controlled to set the growing condition in first plant growing drawer **121** to 1 atmospheric pressure, that in second plant growing drawer **122** to 1.2 atmospheric pressure, 1.4 atmospheric pressure in third plant growing drawer **123**, and 0.9 atmospheric pressure in fourth plant growing drawer **124**. In another exemplary embodiment, the automatic precision weather system (APWS) in each plant growing drawers **121-124** can be set and observed from touch screen display **130**.

Referring now to FIG. **9**, a flow chart of a method for home gardening **900** of different types of plants simultaneously.

At step **901**, a closed enclosure having a plurality of plant growing drawers, each with a vertical lift door and configured to grow a specific type of plant is provided. The close enclosure of step **901** can be implemented with a smart cabinet **100** as described in FIG. **1**-FIG. **7**(B) above. In many aspects of the present invention, smart cabinet **100** used to implement step **901** has vertical lift door **310** that opens and closes almost parallel to the outer front surface of smart cabinet **100** by virtue of a pair of upward curved hinges **315** and pneumatic arms **316**.

At step **902**, an automatic precision weather system (APWS) is provided for each plant growing drawer. In one exemplary embodiment of the present invention, the automatic precision weather system (APWS) of step **902** is implemented which includes an air circulation system as described in FIG. **5**, a water circulation system as described in FIG. **6**, FIG. **7**(A), and FIG. **7**(B), a LED lighting systems **811-814**, mixing tank **240**, and first to fourth water-nutrient solution mixture containers **601-604**. In many aspects of the present invention, the automatic precision weather system (APWS) is implemented to provide a specific growing condition for each plant growing cabinet **121-124** so that a specific type of plants/vegetables can grow therein.

At step **903**, each automatic precision weather system (APWS) is programmed to provide a specific growing condition in each plant growing drawer. Step **903** is realized by controller circuit **230** configured to mix the correct specific water-nutrient solution mixture for each water-nutrient solution mixture containers **601-604**. Then each distribution pump/valve **611-612** is controlled to pump the correct water-nutrient solution mixture to the correct plant growing drawers **121-124**. In there, sprinkler headers **421** mist the roots of the plants/vegetables with the correct water-nutrient solution mixture. Controller circuit **230** also chooses the correct fan speed for fans **521-551** in first plant growing drawer **121**, fans **522-552** in second plant growing drawer **122**, fans **523-553** in third plant growing drawer **123**, and fans **524-554** in fourth plant growing drawer **124**. The correct LED light is also chosen by controller circuit **230**. It is noted that the light can be chosen by controller circuit **230** ranges from, but not limited to, 380 nm to 800 nm. Any light wavelength suitable to any purposes for growing healthy specific plants/vegetables are within the scope of the present invention. Any excess water nutrient solution mixture in water trays **751-754** is controlled to return to the correct water-nutrient solution mixture containers **601-604** so that water will not be wasted. In another aspect of step **903** of the present invention, the automatic precision weather system (APWS) can be controlled manually by touchscreen **131**.

Continuing with step **903**, in various aspects of the present invention, step **903** further includes steps of selecting specific plant to grow in each of plurality of plant growing drawers **121-124**; filling water to a proper level in mixing tank **240**; pouring a nutrient solution from first solution tank **210** and second solution tank **220** into the mixing tank **240** until the specific water nutrient solution mixture is reached; pumping the specific water-nutrient solution mixture to one of the plurality of water-nutrient solution mixture containers **601-604**; repeating the above steps until all chambers of the plurality of water-nutrient solution mixture containers **601-604** are filled with different specific water-nutrient solution mixtures for different specific plants; and controlling the automatic precision weather system (APWS) to provide said specific growing condition to specific plant in each of plurality of plant growing drawers **121-124**.

Step **903** can be implemented by a computer-implemented software program stored in a non-transitory memory device of controller circuit **230**. It will be noted that processes **200-900** are performed by a computer software program **190** that is stored in a non-transitory computer readable medium of network server device **140**. The non-transitory computer readable medium includes optical memory such as CD, DVD, HD-DVD, Blue-Ray Discs, etc.; semiconductor memory such as RAM, EPROM, EEPROM, etc.; and/or magnetic memory such as hard-disk drive, floppy-disk drive, tape drive, MRAM, etc. The computer software program also includes instructions that display a graphic user inter-

face (GUI) on the display screen of touch screen display **131** and/or any combination thereof. When the GUI is activated by a user, step **903** is performed and the automatic precision weather system (APWS) is set as described above to achieve specific growing conditions for specific plants/vegetables.

Finally, at step **904**, with specific growing condition for each plant growing drawer is established, specific plants/vegetables are grown and cultivated in each plant growing drawer. Step **904** is implemented by growing the following four groups of plants/vegetables:

Group I: a nutrient ratio of 40 Part per million (PPM) and a pH level of 6.0 to 7.0 in first plant growing drawer **121**; example of group I includes water cress.

Group II: a nutrient ratio of 540-1,000 Part per million (PPM) and a pH level of 6.0 to 7.0 in a second plant growing drawer **122**; example of group II includes artichokes, lettuce, asparagus, corianders, and cinnamon.

Group III: a nutrient ratio of 1,200-1,600 Part per million (PPM) and a pH level of 6.0 to 6.5 in third plant growing drawer **123**; example of group III includes beans, bell peppers, carrots, cauliflowers, mints, basils, and cucumbers.

Group IV: a nutrient ratio of 1,700-2,100 Part per million (PPM) and a pH level of 5.5 to 6.5 in fourth plant growing drawer **124**; example of group IV includes tomatoes and cabbages.

The foregoing description details certain embodiments of the invention. It will be appreciated, however, that no matter how detailed the foregoing appears in text, the invention can be practiced in many ways. As is also stated above, it should be noted that the use of particular terminology when describing certain features or aspects of the invention should not be taken to imply that the terminology is being re-defined herein to be restricted to including any specific characteristics of the features or aspects of the invention with which that terminology is associated. The scope of the invention should therefore be construed in accordance with the appended claims and any equivalents there.

DESCRIPTION OF NUMERALS

100 smart cabinet for home gardening
110 top section
120 middle section
121 first plant growing drawer for growing a first type of plant
122 second plant growing drawer for growing a second type of plant
123 third plant growing drawer for growing a third type of plant
124 fourth plant growing drawer for growing a fourth type of plant
130 bottom section
131 a touch screen display
140 air outlet openings at the bottom side of the smart cabinet
200 a top view of the top section that reveals its components
201 front side
202 back side
203 left side
204 right side
210 first organic solution container
211 first nutrient pump
220 second organic solution container
221 second nutrient pump
230 controller circuit
240 mixing tank
241 water pump
251 first suction fan and air filter
252 second suction fan and air filter
260 top section lid
261 first array of air input slits
262 second array of air input slits
300 structure of inner structure of a plant growing drawer
310 vertical lift door
311 plant growing tray
312 an array of circular openings
313 air inlet openings
314 air outlet openings
315 first upward curved hinge
316 first pneumatic arm
317 second upward curve hinge
318 second pneumatic arm
320 seedling box
330 input/output water faucet
400 cabinet frame
401 top frame bars
402 bottom frame bars
403 left frame bars
404 right frame bars
405 vertical bar
406 top section base
407 middle section bases
408 bottom section base
410 plant growing tray in general
411 array of circular openings
420 spraying tube
421 sprinkler heads
430 water container
501 first hollow rectangular tube
502 second hollow rectangular tube
503 third hollow rectangular tube
504 fourth hollow rectangular tube
511 first air suction fan
512 second air suction fan
513 third air suction fan
514 fourth air suction fan
521 first circular air opening in first plant growing drawer
531 second air opening in first plant growing drawer
541 third air opening in first plant growing drawer
551 fourth air opening in first plant growing drawer
522 first circular air opening in second plant growing drawer
532 second air opening in second plant growing drawer
542 third air opening in second plant growing drawer
552 fourth air opening in second plant growing drawer
523 first circular air opening in third plant growing drawer
533 second air opening in third plant growing drawer
543 third air opening in third plant growing drawer
553 fourth air opening in third plant growing drawer
524 first circular air opening in fourth plant growing drawer
534 second air opening in fourth plant growing drawer
544 third air opening in fourth plant growing drawer
554 fourth air opening in fourth plant growing drawer
601 first water nutrient solution mixture container
602 second water nutrient solution mixture container
603 third water nutrient solution mixture container
604 fourth water nutrient solution mixture container
611 first distribution pump/valve
612 second distribution pump/valve
613 third distribution pump/valve
614 fourth distribution pump/valve
631 distribution conduit

632 cooling conduit
701 first water pipe
702 second water pipe
703 third water pipe
704 fourth water pipe
711 first receiving pump/valve
712 second receiving pump/valve
713 third receiving pump/valve
714 fourth receiving pump/valve
721 connection pipe
751 first water tray in first plant growing drawer
752 second water tray in second plant growing drawer
753 third water tray in third plant growing drawer
754 fourth water tray in fourth plant growing drawer
801 base
802 base frame
803 glass cover
804 LED lighting system and frame
811 LED lighting system for first plant growing drawer
812 LED lighting system for second plant growing drawer
813 LED lighting system for third plant growing drawer
814 LED lighting system for fourth plant growing drawer

What is claimed is:

1. A smart cabinet for home gardening, comprising:

a top section comprising a controller circuit, a water tank, and at least one nutrient solution tanks;

a middle section comprising a plurality of plant growing drawers arranged vertically;

a bottom section comprising a plurality of water-nutrient solution mixture containers and a valve/pump network arranged so as said valve/pump network is controlled by said controller circuit to provide a specific water-nutrient solution mixture having a specific water nutrient ratio for growing a specific group of plants in each of said plurality of plant growing drawers;

a lighting system, positioned on a ceiling of each of said plurality of plant growing drawers, capable of providing different type of lights for a photosynthesis process for said specific group of plants in each of said plurality of plant growing drawers;

a plant growing tray, located in each of said plurality of plant growing drawers, having an array of circular openings, each of said array of circular openings containing a sponge pod with a hole formed at a center to store a seed of said specific group of plants;

a nutrient spraying network, positioned below said water tray in each of said plurality of plant growing drawers and in communication with said plurality of water-nutrient solution mixture containers and said valve/pump network, capable of misting said specific water nutrient solution mixture from a bottom of said plant growing tray into roots of said group of specific plants in each of said plurality of plant growing drawers;

a water tray, positioned below and configured to collect said specific water nutrient solution mixture from said water tray;

a water circulation system operable to provide water to said water tray and to collect excess of said specific water nutrient solution mixture from said water tray back to said said plurality of water-nutrient solution mixture chambers; and

an air circulation system capable of circulate different amount of air for said specific group of plants inside each of said plurality of plant growing drawers; wherein said plurality of plant growing drawers further comprises:

a first plant growing drawer configured to grow a first specific group of plants that has a nutrient ratio of 40 Part per million (PPM) and a pH level of 6.0 to 7.0;

a second plant growing drawer configured to grow a second specific group of plants that has a nutrient ratio of 540-1,000 Part per million (PPM) and a pH level of 6.0 to 7.0;

a third plant growing drawer configured to grow a third specific group of plants that has a nutrient ratio of 1,200-1,600 Part per million (PPM) and a pH level of 6.0 to 6.5; and

a fourth plant growing drawer configured to grow a fourth specific group of plants that has a nutrient ratio of 1,700-2,100 Part per million (PPM) and a pH level of 5.5 to 6.5.

2. The smart cabinet of claim 1 wherein said top section further comprises an air filter and exhaustion fans electrically connected to said controller circuit.

3. The smart cabinet of claim 1 wherein said water container and said at least one nutrient solution containers further comprises:

a pH level meter;

a nutrient sensor; and

a water level sensor, all are electrically connected to said controller circuit.

4. The smart cabinet of claim 1 wherein each of said plurality of plant growing drawers further comprises:

a plurality of air inlet openings positioned on a back of each of said plurality of plant growing drawers; and

a plurality of air outlet openings positioned on side walls of each of said plurality of plant growing drawers.

5. The smart cabinet of claim 4 wherein said air circulation system further comprises:

a plurality of air inlet slits positioned on a top of said top section;

a plurality of air outlet slits positioned at a bottom front of said bottom section; and

a plurality of electrical fans, controlled by said controller circuit so that air is entered and circulated vertically from said array of air inlet slits and said plurality of air inlet openings and distributed inside each of said plurality of plant growing drawers and then exit from said plurality of air outlet openings and said plurality of air outlet slits.

6. The smart cabinet of claim 1 wherein said bottom section further comprises a water sprinkler system connected to an outside water source to provide water to said water tank.

7. The smart cabinet of claim 1 wherein each circular opening has a diameter of 50 cm and a distance from a perimeter of adjacent circular openings are 100 cm and wherein said tray further comprises 45 circular openings for growing said specific group of plants.

8. The smart cabinet of claim 2 wherein said lighting system comprises an array of light emitting diodes (LEDs) and each of said plurality of plant growing drawers has a different array of LEDs that emit a frequencies ranging from 380 nm to 800 nm for said specific group of plants.

9. The smart cabinet of claim 1 further comprising a plurality of air filtering devices located on sidewalls of said smart cabinet and having a capacity of 360 m^3 per hour.

10. The smart cabinet of claim 3, further comprising a display device, mechanically connected to a front side of said fourth plant growing drawer and electrically coupled to said controller circuit, configured to display:

a pH level from said pH level meter;

a nutrient measurement from said nutrient sensor; and

a water level from said water level sensor, all are electrically connected to said controller circuit.

11. The smart cabinet of claim **1** wherein each of said plurality of plant growing drawers further comprises a vertical lift door configured to open and close vertically.

12. The smart cabinet of claim **11** wherein said vertical lift door further comprises an upward curved hinge permanently fastened to a middle of said smart cabinet in front of said plant growing drawer; and a pneumatic arm connected to said upward curved hinge and to a bottom of said plant growing drawer so as when said pneumatic arm extends outward, said vertical lift door slides upward close to and almost parallel to the front surface of said smart cabinet; and wherein when said pneumatic arm withdraws said vertical lift door slides back to close said plant growing drawer.

13. The smart cabinet of claim **5** wherein said plurality of air inlet slits further comprises a first array of parallel rectangular openings formed on said top of said top section.

14. The smart cabinet of claim **5** wherein said plurality of air outlet slits further comprises a second array of parallel rectangular openings formed on said bottom front of said bottom section.

15. The smart cabinet of claim **5** further comprising:

a first hollow rectangular tube, mechanically connected to a back wall of said smart cabinet, extending vertically from said top section to said fourth plant growing drawer;

a second hollow rectangular tube, mechanically connected to said back side of said smart cabinet, extending vertically from said top section to said fourth plant growing drawer and parallel to said first hollow rectangular tube;

a third hollow rectangular tube, mechanically connected to a first side wall of said smart cabinet, extending vertically from said first plant growing drawer to said bottom section;

a fourth hollow rectangular tube, mechanically connected to a second side wall opposite to said first side wall of said smart cabinet, extending vertically from said first plant growing drawer to said bottom section and parallel to said third hollow rectangular tube.

16. The smart cabinet of claim **15** wherein said plurality of electrical fans further comprises:

a first electrical fan mechanically coupled to the top of said first hollow rectangular tube;

a second electrical fan mechanically coupled to the top of said second hollow rectangular tube;

a third electrical fan mechanically coupled to said the bottom of said third hollow rectangular tube; and

a fourth electrical fan mechanically coupled to the bottom of said fourth hollow rectangular tube.

17. A plant growing apparatus, comprising:

a controller circuit;

a plurality of drawers configured to grow different plants in each of said plurality of drawers;

a plurality of water-nutrient solution mixture containers and a valve/pump network arranged so as said valve/pump network is controlled by said controller circuit to provide a specific water-nutrient solution mixture having different water nutrient ratios for growing said different plants;

a lighting system, positioned inside said plurality of drawers, capable of providing a specific light frequencies for a specific photosynthesis process for said specific plant grown inside each of said plurality of drawers;

a ventilation system operable to provide air flows for each of said plurality of drawers;

a water circulation system operable to provide a specific amount of water to said specific plant grown in each of said plurality of drawers using said controller circuit; wherein said plurality of drawers further comprises:

a first drawer configured to grow a first specific plant that has a nutrient ratio of 40 Part per million (PPM) and a pH level of 6.0 to 7.0;

a second drawer configured to grow a second specific plant that has a nutrient ratio of 540-1,000 Part per million (PPM) and a pH level of 6.0 to 7.0;

a third drawer configured to grow a third specific plant that has a nutrient ratio of 1,200-1,600 Part per million (PPM) and a pH level of 6.0 to 6.5; and

a fourth drawer configured to grow a fourth specific plant that has a nutrient ratio of 1,700-2,100 Part per million (PPM) and a pH level of 5.5 to 6.5.

18. The plant growing apparatus of claim **17** wherein each of said plurality of drawers further comprises a plant growing tray having an array of circular openings, each of said array of circular openings contains a sponge pod with a hole formed at a center to store a seed of said specific plant.

19. The plant growing apparatus of claim **17** further comprising a nutrient spraying network, in fluid communication with said plurality of water-nutrient solution mixture containers and said valve/pump network, capable of misting said specific water nutrient solution mixture into roots of said specific plant.

20. The plant growing apparatus of claim **17** further comprising:

a pH level meter;

a nutrient sensor; and

a water level sensor, all are electrically connected to said controller circuit.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 10,709,076 B2
APPLICATION NO. : 16/139097
DATED : July 14, 2020
INVENTOR(S) : Pham

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

On the Title Page

Item (71), the Applicant Name:
Tuan Anh Pham
Please change to:
Treant Protector PTE. LTD.

Signed and Sealed this
Seventh Day of December, 2021

Drew Hirshfeld
Performing the Functions and Duties of the
Under Secretary of Commerce for Intellectual Property and
Director of the United States Patent and Trademark Office